

BEYOND

TEXTBOOKS:

THE LEARNING RETURN ON INVESTMENT

Total Cost of Ownership Report



October 2011



Beyond

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Beyond

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Total Cost of Ownership Report

Virginia Department of Education

Dr. Patricia I. Wright, Superintendent of Public Instruction

Lan Neugent, Assistant Superintendent of Technology, Career & Adult Education

Dr. Tammy McGraw, Director of Educational Technology

Primary Report Author

Dr. John D. Ross, Consultant

www.TeachLearnTech.com

INTRODUCTION

During the 2010-11 school year, teachers from 15 classrooms in four Virginia school divisions participated in the first phase of a pilot program that used digital textbooks presented on multipurpose portable devices. The *Beyond Textbooks* pilot was part of *Learning without Boundaries*, an initiative of the Virginia Department of Education's Office of Educational Technology that incorporates wireless mobile handheld technology into teaching and learning.

The bulk of the pilot focused on digital texts in history and social studies in two grade bands. Fourth-grade students in Henry and Arlington counties used Victory Productions' new Early Jamestown application, or *app*, which operated on a new publishing platform developed by Adobe. Victory Productions used approximately 15-20% of a state-approved, print-based textbook to create the digital *app*, with the content formatted specifically for iPads; this created an easy-to-use interface so students could interact with the content, change the size of graphics and text with finger gestures, and orient content to portrait or landscape layouts depending on how they held the devices. The *app* featured short digital videos from the Jamestown-Yorktown Foundation that were embedded in the text as well as maps and diagrams with some interactivity, such as being able to expand the window for viewing.

Eighth-, ninth-, and tenth-grade students in the Pulaski, Newport News, and Arlington school divisions used digital texts and supporting applications developed by Pearson. Using input from teachers in the pilot, Pearson developed simple games and quizzes to support the text and to allow students to self-assess their content and vocabulary knowledge. The Pearson content also represented approximately 15-20% of the annual social sciences curriculum. During the pilot, the Pearson solution changed formats from a browser-based text to an e-text designed specifically for the iPad; this provided greater functionality in terms of searching, hyperlinking, and support for multimedia content. See the year one report (Virginia Department of Education, 2011) for additional details about Phase I of the pilot and further descriptions of the applications.

This report addresses the costs involved with the pilot and the conditions necessary for delivering high-quality instructional materials at a lower cost. Costs for a project like this extend beyond the dollars spent on hardware and software. Understanding these costs should help others implement digital textbook initiatives by determining potential needs while considering existing and new resources. The report also includes cost-savings tips from division leaders.

The report is not a cost comparison between digital and print textbooks; this type of analysis is not possible at this time for several reasons. First, the pilot used only a small sampling of comparable print-based books (15-20%). The potential costs of developing and delivering a larger segment of printed books is unknown at this time. Second, the definition of *digital textbooks* is in flux. Different digital textbooks can include a wide variety of functions, all of which affect cost. In fact, the products used in this project underwent significant changes in functionality just during the pilot. This topic is explored in greater detail later in this report.

TOTAL COST OF OWNERSHIP

Total cost of ownership (TCO) suggests that any initiative has cost implications beyond obvious material costs. The concept of TCO has become increasingly more prevalent in education due to the growing number of computing devices. Most notably, the Consortium for School Networking (CoSN) launched the Taking TCO to the Classroom effort in 1998 to help educators understand some of the costs that go beyond initial hardware purchases. TCO considerations extend to other systems, including physical structures and resources as well as personnel—and may have both direct (obvious or hard) costs and indirect (hidden or soft) costs. TCO models can help educators project both direct and indirect costs, but only a cost analysis can verify the accuracy of these projections.

CoSN's original TCO Rubric included the categories of professional development, support, software, replacement costs, retrofitting, and connectivity (McIntire, 2004). The K12 TCO Calculator, developed by the Institute for Advancement of Emerging Technologies in Education, included the categories of computers and peripherals, distance-learning equipment, telecommunications, spares, training, repairs, building modifications, furniture and ergonomics, and electrical power (Ross & Zeisler, 2005). McKenzie (2003) suggests that TCO models should also include less tangible factors, such as organizational impacts, building spirit, and faculty support for the initiative.

Projecting TCO helps school and division leaders plan for new initiatives and determine the potential impact on the other systems where the project will reside. It also helps planners determine specific costs and identify existing resources that can be leveraged. For example, a digital textbook that might ultimately replace a print textbook could be supported by existing textbook allocations and by existing professional development budgets. That same digital textbook may require some upfront costs in terms of supporting curricular materials, network infrastructure, and the training of pedagogical and technical support personnel. A TCO model can help educators determine these costs and strike a balance between existing and new resources.

Success is often described in terms of return on investment, which, for businesses, is framed in terms of greater efficiency, productivity, and hopefully increased profits. In education, the intended end product is successful learners, so, while understanding actual costs is important, educators should consider other returns on technology investments, or the learning return on investment. Costs should be judged not just on whether they are more or less expensive than an alternative—or whether they improve efficiency—but also on the learning return. Sometimes, project costs may be higher than the alternatives, but, if the learning return is high enough, these costs can be justified.

DEFINING A DIGITAL TEXTBOOK

One of the most critical terms in this report is one that has the greatest opportunity for misunderstanding: *textbook*. It is filled with various connotations due to people's prior experiences with printed textbooks and its prominent position in most education systems. Going "beyond textbooks," however, requires one to consider what textbooks can be in the future.

During the early adoption of digital technologies in classrooms, such as the introduction of microcomputers in the 1980s, researchers (Dwyer, Sandholtz, & Ringstaff, 1991) noted that teachers tended to adopt technologies in a series of stages. First, they would replicate traditional resources and strategies using technology, then adapt or modify those resources and strategies based on available technologies, and, finally—at least with some teachers—create entirely new teaching and learning environments not possible without the technologies; in other words, technology adoption by teachers developed from *replication* to *modification* to *transformation*. This continuum of developing skills and practices also applies to the adoption of digital textbooks and is central to understanding potential learning returns.

Representing the early stages of the continuum, some printed textbooks have been replicated in digital forms using software such as Adobe's Portable Document Format (PDF). Some textbook publishers currently promote static PDF versions of their printed textbooks as "digital textbooks" because, technically, these texts are in electronic formats and do capitalize on the limited functionality of PDF documents, such as hyperlinking, annotations and commenting, and text-to-speech. Textbooks in this stage often retain the formatting of printed documents—rather than using digital technologies to vary screen layouts or accommodate different learning needs—and the functionality is derived from the platform, such as Adobe's PDF format, rather than being designed specifically for the textbook application.

Moving to the modification stage of the continuum, some digital texts incorporate more technological affordances. Not only are the layouts more dynamic, but the content incorporates more robust media, such as videos, animations, and images that can be manipulated by the user. Some publishers currently offer a suite of tools to supplement the text—online or stand-alone—which may include audiovisual information and drill-and-practice exercises and games. Texts of this nature begin to capitalize on the functionality of digital media and should serve as a bridge to what future digital textbooks might become.

The pilot project used textbooks that have characteristics of both the replication and modification stages. This is important because these stages lend themselves to specific types of pedagogies and thus support certain kinds of learning. Traditionally, textbooks have conveyed information that students need to recall and comprehend, regardless of the students' abilities to decipher or understand the academic language. More recent products have incorporated digital media to support different learner preferences, such as adapting the content to help students who need to see the "big picture," who are more visual or auditory learners, or who need to manipulate and transform data and information.

What lies beyond? The “textbook” of the future is yet to be invented; however, it most likely will help teachers attend to the diverse learning styles and preferences of all students. It will provide a learning environment that supports higher-order application and analysis of foundational knowledge—what many consider to be the upper levels of Bloom’s taxonomy. Students will not just observe or manipulate the content, they will interact with it, meaning that the textbook could go beyond just presenting basic facts and information that support recall and comprehension to providing an environment where students can create their own learning artifacts—expanding the textbook as a codeveloper. It will support communication and collaboration between teachers and students and among the students themselves—possibly even others who may not be physically or temporally present. It will allow students to practice new skills, test new knowledge, and receive feedback on their performances virtually instantly. It will promote creative and innovative thought and allow students to monitor and demonstrate their new learnings within the domain of study, perhaps through existing media and formats or through new hybrids. It also will serve as a critical component of a larger suite of tools to support and monitor student learning, including exchanging data kept in student information systems and/or shared through learning management systems.

A textbook that promotes more passive uses and lower levels of cognition, such as recall and comprehension, is likely to produce less learning return on investment than one that promotes interaction through critical thinking and complex problem solving—requiring students to apply foundational skills and knowledge, create new information, and incorporate this into their schema. When considering the total cost of ownership, it is important to understand where the textbooks in the pilot project fall along the continuum. Figure 1 suggests how textbooks might function in different stages. Predicting the future is not an exact science, so the description at the transformation stage can be considered only a best guess.

Figure 1. Potential stages of textbook development

Replication	Modification	Transformation
A digitized version of a printed text that offers few or no modifications to the printed layout but that capitalizes on some functionality inherent to its platform (e.g., hyperlinks, simple annotations, bookmarking)	A digital version of information commonly found in a textbook but modified to leverage the benefits of digital media, including dynamic presentation of text and images, hyperlinking, audio, video, and other multimedia	A digital environment with foundational content as a launching pad to promote higher-order skills, metacognition, complex problem solving, communication and collaboration, the creation of student artifacts, and the tracking of student performance data

There are some obvious reasons why the textbooks in the pilot resembled earlier stages on the continuum rather than the transformation stage. The most obvious is that the project was treading new ground in terms of authoring and delivery technologies that were previously unavailable. Division leaders reported that the texts themselves changed during the pilot and that publishers requested feedback from teachers and used that feedback to create new features and functionality. It is difficult to advance to the transformation stage when educators and textbook developers are still learning what is possible.

The pilot project also followed in the footsteps of many previous technology integration endeavors by incorporating technologies developed for other purposes and adapting them for education. From the television to word processing and spreadsheets, many common classroom technologies were not designed originally for teaching and learning. Adaptation takes time and effort.

So, the simple question of whether digital textbooks cost more than printed textbooks is not easy to answer. What is meant by *textbook*? How is it used? What kind of learning does it support? This report presents considerations for those interested in adopting digital texts to receive the most learning returns on their investments.

HARDWARE

While several multipurpose portable devices were considered for the pilot project, the project ultimately selected Apple's first-generation iPad. Note that the iPad2 did not become available until later in the school year; its added functionality addresses some original implementation issues. More information about the selection of the iPad is provided throughout the report and in the year one report (Virginia Department of Education, 2011).

Unfortunately, none of the multipurpose portable devices considered for the pilot were designed for classroom use (as is often the case with new technologies), so all had limitations to overcome in terms of functionality and operational considerations. In addition, all were designed for individual users, not multiple users, which provided challenges that had to be addressed creatively.

Implementation Models

During the pilot, the school divisions adopted two different implementation models. While there is no hard data related to student outcomes per model, each model has unique characteristics that could influence the learning return on investment.

The most commonly adopted model in this project was a per-classroom approach, in which secondary schools purchased classroom sets of devices, usually 30. The benefits of this approach were that the devices remained at the schools and could reach a greater number of students per device; however, the downside was that this approach was not ideal for individual learning since none of the devices were designed for multiple users. As a result, these students had difficulty creating

and storing artifacts, such as notes or presentations, in a confidential or secure environment without help from third-party applications.

The second implementation model was adopted by the two divisions with elementary classrooms. This per-student approach gave all the students access to their own devices, which they could also take home. They could create and store artifacts that incorporated text, images, or other media in a secure and confidential manner and then transport the devices with them to other classes or to home for continued learning. In these divisions, the parents reported greater interaction with their children's learning at home. Janet Copenhaver, director of Technology/Media for Henry County Public Schools, stated, "It's much easier for parents to find out, 'What did you learn in school today?' when they can say, 'Show me what you learned today with your iPad.'"

A glaring negative aspect to this approach is the increased cost because it requires more than the 30 devices per classroom—as used in the secondary schools. As such, the type of implementation model greatly impacts the number and total cost of devices required to start up the effort. The potentially significant investment for the 1:1 model (one device for each student) has to be tempered with the types of learning gains expected from the project and how the devices themselves will support student learning outcomes.

Additional Hardware Concerns

Most multipurpose portable devices come with all the required supporting hardware, like chargers and cables, for personal use; however, additional hardware may be needed in a classroom or multiuser setting. Spare equipment, such as extra iPads and chargers, should also be considered in case devices are broken, lost, or otherwise unavailable. Purchasing spare equipment typically costs between five and ten percent of the original cost and can ensure that learning continues when the original device malfunctions. Spares are more important in a per-student model than with the per-classroom approach.

Durability. A common reason given for digital textbooks is to overcome the sheer size and weight of printed textbooks that young children must carry. Devices like iPads seem ideal for this reason as they are small, light, and easy for very young students to operate; however, the size and weight also make some educators wonder whether the devices are durable enough for student use. Despite this, very few devices were broken or needed to be repaired during the pilot. In part, this may be because many of the devices were implemented in the per-classroom model and were not taken home. But, even in the divisions where elementary students took the devices home, there were few mishaps.

Arlington County, which had no broken or lost devices during the pilot, allowed students to take their iPads home over weekends; one school offered a parent pick-up service in which teachers personally handed over the iPads to parents after school on Fridays. Students took home fully charged devices to eliminate the need for transporting the charger, which could have been easily misplaced. In the largest installation, Henry County, elementary students could take their iPads home every day (devices at the upper grades stayed at school); of the 1,750 devices, only two screens were broken, and three chargers were not turned in. Neither Newport News nor Pulaski reported any broken or lost devices.

Apple products have an optional **extended warranty** that costs extra; however, one division found lower-cost **insurance** for their devices that required each device to be protected by a **case**. For anyone planning a similar project, cases could be an important investment regardless of the insurance—since the devices will be used by young children and since dings or dents in a device can void the warranty or insurance policy. In Henry County, some parents shared the cost of the outside insurance, which reduced school funds allocated to the project.

Mobile carts and laptops. Mobile carts are increasingly common for many portable devices, such as laptops and handheld computers. They facilitate easy storage and recharging of multiple devices at one time, such as a classroom set of 30. While not available at the beginning of the pilot, two types of synching carts went on the market during the 2010-11 school year and were purchased by some of the divisions. These carts allowed the schools to store the devices in secure locations and made it easier to update or synch all the devices at once, saving significant maintenance time. At the time of this report, Apple maintained two brands of mobile carts; however, based on the number of carts now available for laptop computers, it is reasonable to expect that additional vendors will enter the market, that mobile carts will eventually become available elsewhere, and that this competition ultimately will decrease costs. Two divisions created their own by retrofitting carts formerly used for laptops.

For the original iPad and the iPad2, a designated **computer** is required to operate iTunes, which is necessary for downloading all software updates. Some of the divisions purchased new laptops, but existing laptops also would work. The laptops can be used to synch all the devices in the school individually or in rotations of 30 with a cart. Although the carts and laptops cost more money, they also save staff time.

Operating system. As with most technology initiatives, the most constant aspect is change, and changes often come quickly. At the time of this report, Apple was promoting a new operating system for iPads and other devices—iOS 5, the third operating system since the launch of the pilot—that will not require a computer. Through this system, devices will be able to synch to upgrades and new apps through a cloud environment. While this new feature sounds promising, it is unknown how it will function in a multiuser environment. The devices are still designed for single users, but if schools can synch a classroom set of devices without a cart and laptop, it could reduce start-up costs. On the other hand, an upgrade in operating systems could also present some concerns as, historically, some upgrades have reduced the performance of some devices due to insufficient resources for running the new system and its upgraded apps. Operating system changes also can frustrate users, especially novices, due to changed interfaces. In terms of return on investment, the best advice is to approach upgrades with caution and then test, test, and retest before deploying schoolwide or divisionwide. No division wants to bear the added cost of replacing all its devices or implementing significant professional development to offset an upgrade.

Earphones and earbuds. Because the digital texts incorporated multimedia, one division has recommended purchasing **earphones** or earbuds for student use during class. Earbuds with built-in microphones, a more expensive option, would allow students to create and later hear their own audio; due to the benefits, purchasing at least a few per classroom could be a justifiable expense.

Other peripherals. These wireless devices print only to a **wireless printer**, which some schools and divisions do not own. In addition, some schools needed to add digital or document cameras; however, the iPad2 has a camera and will connect to a projector, eliminating the need for these types of peripherals.

Cables. The modern, multimedia classroom often includes projectors and/or interactive whiteboards. As a result, additional **cables** and adapters may need to be purchased to interface with projectors, cameras, monitors, keyboards, and speakers. So, it is important to determine *how* all devices will be used in classrooms and which other devices they must interface with to support teaching and learning.

Bulk purchases. To save money, bulk purchases can produce price reductions. In the case of the pilot, when purchased in sets of 10, iPads were \$20 cheaper per unit (\$200 savings per set). While this may not sound like much money compared to the total investment, it is enough to purchase a wireless printer or several sets of earphones.

Other computers. In terms of offsetting hardware costs, Copenhaver noted that the iPads are not replacing computers at this time. Students must still take accountability tests (the Virginia Standards of Learning assessments) online, so each school must have an adequate number of computers for students to participate during the testing window. She envisions a day, though, when multipurpose portable devices could replace other computers as long as the testing applications provide the same level of security as current desktop and laptop computers. As an example, according to Jeannine Richardson, instructional media integration coordinator for Arlington County Public Schools, one of the teachers in the pilot incorporated online classroom testing, which students completed on their iPads.

Other versions of the texts. Although it is not a hardware expense, another cost is that the divisions still purchase other versions of the texts, some printed and some electronic. Even if full versions of these digital textbooks become available, divisions may still need some copies of printed texts. If the devices are not available—whether through loss, need for repairs, or taken away for inappropriate use—each student would still have access to curricular materials. In some cases, this may necessitate relying on print.

Figures 2 and 3 outline potential hardware cost considerations for the first year of a digital textbook initiative—based on input from division leaders involved in the pilot. The amounts and costs are only examples and do not correspond to a real initiative. A spreadsheet version of the figures in this report is also available and can be used to project costs for any similar device that supports digital textbooks, not just iPads. Some fields represent underlying calculations that may not be apparent in the figure. All amounts and costs on the spreadsheet can be changed or even zeroed out if the variable is not planned or necessary. Comments are presented as guidance and for clarification of some embedded calculations.

Figure 2. Potential device costs during start-up using sample figures

Start-Up Year

First, choose the implementation model:

Per Student			Per Classroom		
Variable	Amount	Comment	Variable	Amount	Comment
# of devices for students	60		# of class sets		
			# per set		Leave blank if # per set varies
			# of devices for students		To override, enter total # of devices
# of devices for teachers	2		# of devices for teachers		
Subtotal	62		Subtotal		

Variable	Amount	Cost per Unit	Total	Comment
% of spare or loaner devices	10%		6	Default is 10%; to override, enter new percentage or 0; percentage may be lower per classroom
TOTAL DEVICES FOR START-UP	68	\$479.00	\$32,572.00	Volume purchasing may result in a discount price
Warranty or insurance per device	68	\$79.00	\$5,372.00	Leave blank if no warranty or insurance purchased; otherwise, enter dollar amount per device
Shipping, handling, other fees			\$0.00	Enter total cost
SUBTOTAL FOR DEVICES ONLY			\$37,944.00	

Figure 3. Additional hardware considerations

Variable	Amount	Cost per Unit	Total	Comment
Adapter for projector	2	\$29.00	\$58.00	Default is 1 per teacher device; amount can be overridden; enter cost per device
Additional chargers	0	\$29.00	\$0.00	Default is 0 because of possibility of mobile carts; number can be overridden; enter cost per device
Earphones or earbuds	68	\$29.00	\$1,972.00	Default is 1 per device; can be overridden
Cases	0	\$40.00	\$0.00	Default is 0; some insurance may require cases, which are also recommended for the per-student implementation model because of transporting the devices to and from home and school
Mobile cart	2	\$2,479.00	\$4,958.00	Default is 1 per 30 devices
Laptop or other computer	2	\$1,082.00	\$2,164.00	Default is 1 per cart
Printer	0	\$129.00	\$0.00	Default is 0; iPads require a wireless printer
Additional hardware 1	0	\$0.00	\$0.00	Consider cameras, additional connectors, keyboards, monitors, speakers, etc.
Additional hardware 2	0	\$0.00	\$0.00	Consider cameras, additional connectors, keyboards, monitors, speakers, etc.
Additional hardware 3	0	\$0.00	\$0.00	Consider cameras, additional connectors, keyboards, monitors, speakers, etc.
HARDWARE SUBTOTAL			\$9,152.00	

These figures represent only the costs at startup. Ongoing costs likely would be less in many categories if the project does not grow to include additional teachers and students, especially after the initial hardware investment. Division leaders interviewed for this report hope the devices will have usable lifespans of four or possibly even five years, like their existing replacement cycles for computers. At that point, another investment in devices would be required to maintain the project. By that time, however, the cost of devices may decrease, may be assumed by families—whole or in part—or may be covered by alternative options.

Based on the pilot project, phase two may require additional software purchases. Several of the divisions allowed teachers to preview, test, and recommend free and for-fee applications, and some will purchase a few of these applications during year two. The next section considers costs related to software.

SOFTWARE

In terms of the pilot, the digital texts were provided at no cost to schools, so there is no basis for determining cost comparisons or subsequent budget projections for software. The digital texts in the pilot also only represent a portion of a complete book (approximately 15-20%), and it's not clear whether this represents 15-20% of the total cost to develop an entire digital text or whether the costs are front-loaded with start-up costs. Estimating the costs of new digital texts can be complex and could include additional development costs required by the publisher to create or revise materials and the new technologies to support them. The publisher's developmental costs could include hiring or training staff to develop software or to create content assets in new formats, such as HTML5 instead of Flash¹, which likely would result in significant costs (Kelly, 2011).

Some currently approved textbooks are available in both print and electronic versions. Again, the definition of an *electronic version* varies by publisher, but it usually includes numerous resources for teachers and students and could include downloadable supplemental research, multimedia content, games, drill-and-practice exercises, and assessments. In addition, the full text may be available online or in PDF format.

Since publishers provide different types of electronic resources, it is not possible to conduct an "apples to apples" cost comparison. In addition, pricing structures among publishers tend to vary widely—this is clearly evident with the history and social science texts approved by the Virginia Board of Education (2011) (see Figure 4); for example, one publisher offered a suite of electronic resources at a cost higher than the print version and one (note that Glencoe is a division of McGraw-Hill Companies, and Holt McDougal is a division of Houghton Mifflin Harcourt Publishing Company) at a cost 25% less than the print version. In Figure 4, the percentages for the print versions have been rounded to the nearest whole numbers.

¹ Adobe (Towes, 2011) has now released a Flash Media Server 4.5 that should support Flash-based content on Apple devices. This development could make available much more Flash-based content.

Figure 4. Price comparison of print and electronic texts approved for history and social science by the Virginia Board of Education

Publisher	Text	Print	Electronic	Difference	Percentage of Print Version
Glencoe	The American Journey, Early Years	\$76.77	\$80.76	+\$3.99	+5%
Glencoe	The American Journey, Modern Times	\$76.77	\$80.76	+\$3.99	+5%
Glencoe	Glencoe World History: Early Ages	\$82.14	\$86.13	+\$3.99	+5%
Glencoe	Glencoe World History: Modern Times	\$82.14	\$86.13	+\$3.99	+5%
Glencoe	World Geography & Cultures	\$81.00	\$84.99	+\$3.99	+5%
Glencoe	The American Vision	\$82.98	\$86.97	+\$3.99	+5%
Holt McDougal	Holt McDougal United States History, Civil War to the Present, Virginia Student Edition	\$78.65	\$59.00	-\$19.65	-25%
Holt McDougal	Holt McDougal Civics in Practice: Principles of Government and Economics, Virginia Student Edition	\$76.60	\$57.45	-\$19.15	-25%
Holt McDougal	Holt McDougal Ancient World History, Patterns of Interaction, Virginia Student Edition	\$83.75	\$62.85	-\$20.90	-25%
Holt McDougal	Holt McDougal Modern World History, Patterns of Interaction, Virginia Student Edition	\$83.75	\$62.85	-\$20.90	-25%
Holt McDougal	McDougal Littell World Geography	\$78.95	\$59.60	-\$19.35	-25%
Holt McDougal	Holt McDougal The Americans, Virginia Student	\$86.30	\$64.75	-\$21.55	-25%
Holt McDougal	Holt American Anthem	\$83.75	\$62.80	-\$20.95	-25%
Holt McDougal	Holt McDougal United States Government: Principles in Practice	\$82.30	\$61.75	-\$20.55	-25%
Houghton Mifflin Harcourt	Houghton Mifflin Harcourt, Virginia Social Studies: Virginia, United States History to 1865	\$67.50	\$50.65	-\$16.85	-25%

Know What You're Paying For

Regardless of the format, not all textbooks are the same. The bundled services and resources vary among publishers. The comparisons in Figure 4 are based on costs alone and do not consider scope of the content, alignment to curricula and standards, effectiveness, or ease of use. Educators interested in comparing prices should preview and test the resources to assess the effectiveness of the electronic resources and whether the cost is justifiable in terms of learning returns.

Will schools be able to stop purchasing printed textbooks? The answer depends on the amount of curricula that any one textbook would have to cover. In both the elementary and secondary pilot settings, division leaders estimate the digital texts addressed 15-20% of the total annual curriculum—being a pilot, it was not designed to replicate an entire text nor cover an entire curriculum. Not all division leaders held the expectation that, once available, any one textbook solution could cover 100% of the curriculum. Due to the rich array of supplementary and enrichment materials now available, there may be less reliance on using a single text to address an entire curriculum. Debbie Hodges, coordinator of Instructional Technology and Academic Support for Pulaski County Public Schools, noted that her division had already taken steps prior to the pilot to help teachers understand the concept of the “textbook as resource” rather than the “textbook as curriculum.” Division leaders suggested that since many teachers and content experts at the school and division levels routinely create supporting curricular materials, future digital textbooks should cover at least 75-80% of the curriculum—to produce a cost commensurate with printed textbooks.

Management Software

Currently, the iPad lacks management software similar to desktop and laptop computers. Management software is important because it allows school technical support personnel to install and maintain computers quickly across a school or division, often from a distance, which affords cost savings during initial deployment and a reduced need for in-person service calls. Management software is also available for more traditional personal computers and allows teachers to monitor, share, and control student computers in labs and classrooms. This helps teachers focus student attention on activities that support learning and decrease off-task behavior. Since the iPad is developed for individual users, none of these management options are currently available; although, one division leader mentioned that a lower-cost device with strong management software could offer strong competition.

Synching the devices. During the pilot, synching the devices sometimes required a significant amount of time, especially at the beginning. Time, of course, impacts budgets—even for salaried positions—since time spent synching devices could potentially be spent on other duties, such as preparing for lessons, reviewing student data, or performing maintenance. Synching was performed periodically during the pilot as updates were required for the Early Jamestown app, and the Pearson product actually changed from a browser-based to app-based solution.

As mentioned previously, iPads are synched to the iTunes Store; this process currently requires the use of a computer. The new iOS 5 (mentioned earlier) reportedly allows devices to connect wirelessly to

the iTunes Store, but it is unclear whether a classroom set, or hundreds or thousands of iPads distributed across a school or county, can be synched wirelessly. This is a legitimate need since one division expects to have at least 1,000 iPads in year two, and another already crossed that threshold in year one. Originally, division leaders had to synch the devices to a master iTunes account one at a time or come up with innovative *workarounds* that often involved multiple cables and hubs or retrofitted older carts—the introduction of mobile carts significantly improved the synching process and saved substantial time.

Save Money by Saving Time

Mobile carts—whether purchased or retrofitted—saved the participants time since they could recharge and synch up to 30 devices at a time. For devices that use a registration system—similar to the iPad through the iTunes Store—division leaders have recommended registering multiple devices to a single iTunes account rather than trying to create an individual account for each device. Each iTunes account is linked to a specific e-mail address, so the registered e-mail should be a division-based account, as opposed to an individual's account, because personnel and their e-mails can change, which would eliminate the account.

Depending on the number of devices and their locations, you might be able to use a single iTunes account at the class, grade, school, or division levels. It depends on the differences in settings and resources at those levels. For instance, if all fourth-grade teachers in a division have access to the same iTunes resources, a grade-level account could work.

For iPads or iPods, Debbie Hodges recommends becoming familiar with the iTunes playlist-and-folders structure, such as options for setting up multiple “images” within a single account (e.g., fourth-grade or fifth-grade playlist). Decisions about single vs. multiple iTunes accounts will be affected by the distance between schools—schools that are farther apart likely will require multiple accounts.

Managing student data. Another decision involves the management of student-generated documents and other digital learning artifacts. This is less of an issue in a per-student installation since students can keep all their relevant content, applications, and documents on their own devices. In a per-class setting, however, several divisions struggled to find solutions for managing student work because the devices—like all others considered—were not designed for multiple users.

Consider a student who captures notes on an iPad during the first period of the day but has to leave the device in the classroom. These notes could be accessed by every other student who uses that same iPad later in the day or throughout the year. Offloading student work from the iPads must be done wirelessly or through a synching process since iPads do not allow for transferring data via USB flash drives or through other methods typical with desktop or laptop computers. Individualized synching would be an incredible logistical and time burden, so it is not a cost-effective consideration. E-mailing the data is a potential option; however, some divisions, including some in the pilot, do not provide students with e-mail accounts.

Arlington County Public Schools addressed this challenge by using an app—created by its learning management system provider—that allowed students to store and retrieve their work through any Internet-enabled device. In this way, students could create notes, reports, presentations, or other digital artifacts; upload them to network storage; and then access them again at home, in the library, or anywhere else with Internet access. With regard to transferring and storing student data, it appears the highest learning return on investment would be to allow students to e-mail their work or upload it to a learning management system.

Apps—Value beyond the Text

Another factor that makes it difficult to ascertain the total cost of ownership (TCO) of the digital texts is that many educators also used supplementary apps from the iTunes Store—some free, others at a cost. In fact, division leaders consider the proliferation of education apps—more than 14,000 for the iPad just at the time of this report—to be the most significant value-added aspect of using iPads. The sheer number of available apps—what James Maxlow, supervisor of Instructional Technology/Innovation for Newport News Public Schools, referred to as the “richest app ecosystem”—makes the iPad stand out over other devices. Education apps could be a pivotal factor in determining the learning return on investment since apps help teachers convey foundational knowledge and help students apply their knowledge and skills, receive feedback and reinforcement, and monitor their own learning.

During the pilot, several divisions used only free apps, including some that were preinstalled on the iPads, such as the Notes app. All divisions allowed teachers to download and experiment with free and paid apps and to make recommendations for future adoption. Several divisions eventually purchased some apps, most of which were productivity tools, such as apps to create various documents and to support different media—as opposed to content-specific apps since the digital texts themselves contained the relevant content.

Apple currently offers a volume-purchasing program with a significant discount for educators—usually 50% off on 20 or more apps—which can reduce the overall TCO. Depending on the value provided by the app, the fee for a paid app can be justified in terms of saved time, efficiency, or greater effectiveness related to teaching or learning. While hard to quantify, several divisions felt some paid apps provided a return on investment.

It is important to note the difference between a general app, or even an education app, and the textbook apps used in the pilot. Some might question the necessity of purchasing more expensive textbook apps when thousands of free apps are available. Most of the general apps the teachers used were productivity tools, much like the word-processing, spreadsheet, and presentation software used on more traditional computers. It is possible that future textbook apps could also include these types of productivity tools, but, at this time, they remain separate from digital texts.

There are also many general education apps, but they tend to be very limited in scope or focus on only a few skills. Early-literacy apps are prevalent for younger students, and foreign language apps are popular for older students (Shuler, 2009). They tend to allow students to practice shaping letters, solve mathematics problems, learn new vocabulary, or participate in academic games or drill-and-practice activities, among other activities. The most critical difference between most education apps and the

textbook apps in the pilot, however, is quality. Anyone can create and post an app to the iTunes App Store—just as anyone can upload material to the Internet in general. These individuals are not required to have backgrounds in education, learning theory, instructional design, or even the content. In addition, there are no standards for what constitutes a good app or for ensuring the validity of the content.

By contrast, the digital texts in the pilot followed the Virginia Board of Education’s traditional pattern of textbook approval. Just like with printed textbooks, the digital textbooks in this pilot were subjected to thorough reviews by content experts and educators for accuracy and alignment with the Standards of Learning.

Similar to the educational software of the 1980s and the early digital content on the World Wide Web a decade later, apps are in a formative stage of development. Based on the improved quality of educational software and Internet content over time, it is likely that content, learning, and media experts increasingly will develop more education apps, which could significantly improve the quality while decreasing the costs.

In summary, there may be software costs beyond the price of the digital text itself, especially if the text does not cover the entire curriculum. Productivity applications may yield the highest return on investment since they can be used in multiple courses. Thanks to funding from the pilot study, the Early Jamestown app is now available to the public for free through the iTunes Store, but developing accurate content and high-quality media from scratch can be costly. In addition, that cost will ultimately be passed on to the consumer as digital textbook publishers tackle the volumes of content and media yet to be developed. These costs could be reduced as the market for high-quality content increases.

Figure 5 shows a tool that can be used to factor TCO of education software. Once specific software titles are identified, the rows can be adjusted for specific curricular materials broken down by grades and content areas.

Figure 5. Required software

Variable	# of Licenses	Cost per License	Total	Comment
Curricular software (language arts)			\$0.00	Digital textbook, other
Curricular software (mathematics)			\$0.00	Digital textbook, other
Curricular software (social studies)			\$0.00	Digital textbook, other
Curricular software (science)			\$0.00	Digital textbook, other
Curricular software (other)			\$0.00	Digital textbook, other
Curricular software (other)			\$0.00	Digital textbook, other
Curricular software (other)			\$0.00	Digital textbook, other
Curricular software (other)			\$0.00	Digital textbook, other
Productivity software			\$0.00	Document creation/ editing, note-taking, media presentation, etc.
Productivity software			\$0.00	Document creation/ editing, note-taking, media presentation, etc.
Productivity software			\$0.00	Document creation/ editing, note-taking, media presentation software, etc.
Productivity software			\$0.00	Document creation/ editing, note-taking, media presentation, etc.
<i>For multiple-grade implementation, select and copy required rows above and insert the copied cells into this row.</i>				
Management software			\$0.00	For future use— hopefully with a single price per school division
SOFTWARE SUBTOTAL			\$0.00	

INFRASTRUCTURE

As noted in the year one report (Virginia Department of Education, 2011) and echoed by division leaders interviewed for this report, infrastructure is critical because iPads are *wireless* Internet-enabled devices. Infrastructure involves several key factors, including the speed of the Internet connection, the capacity of the internal network, the number of devices already on the network, how many devices a digital textbook initiative add to the network, and how often and for what purposes those devices access the Internet.

In addition to the impact on infrastructure during implementation, the pilot required some upfront costs. The networks in two divisions supported only Windows-based devices, which required technology personnel to take time to authorize the Apple devices to make the proper connections.

Network capacity. The number and locations of wireless access points were another issue with some divisions. Wireless access points were placed in individual classrooms, which improved connectivity but also incurred additional costs. These types of expenses vary based on the expertise or experience of the network personnel. One division with both Apple- and Dell-certified technicians had fewer issues with networking. Arlington County Public Schools initially allowed iPad users to access the Internet through its guest network but has recently re-engineered its network to accommodate iPads and other devices more effectively.

The two largest divisions noted no or few additional burdens on their networks during the pilot because their networks already supported thousands of devices. For example, in Newport News, only 60 iPads were added to a network that already supports 16,000 devices. Certainly, increasing the total number of devices, or even increasing the percentage of digital textbook devices on a network, can increase usage; however, there is no simple formula to determine the associated costs of adding devices like these—it would require each individual division to investigate its own network capacity and the anticipated increased burden on its network. Figure 6 offers suggestions for helping technical support personnel determine network capacity for adding devices.

The divisions that reported decreased network performance also have limited access to high-speed Internet connections—an issue common to many areas of the country, including the Commonwealth. Although this did not translate into greater overall costs, these divisions received less service for their Internet investment than divisions with better broadband connections.

In addition to determining how many devices can be added to a network, divisions also need to anticipate *how* the devices might impact network traffic. For instance, the Pearson text was intended to be streamed, while the Early Jamestown text included short streaming videos. Streaming media of any type can place a significant burden on a network, especially when 30 students or a whole school of students access it at the same time. Content elements that can be downloaded—as opposed to multiple students accessing streaming media resources simultaneously—would reduce the drain on networks; however, periodic updates to downloaded material may still be necessary if changes are made to the original content, which occurred during the pilot.

Acceptable use of the iPads. Home Internet access was less of a concern than originally thought. In the divisions where iPads could be taken home, the students were allowed to access the Internet with their iPads only after they and their parents had received appropriate training and signed an updated acceptable use policy. When returned to the schools, the iPads were reconnected to each division's filtered network, which allowed technical support personnel to monitor all downloaded material. Copenhaver noted that the devices initially were policed heavily in Henry County but that, due to the precautions, inappropriate use was rare. To accommodate students who did not have home Internet access, school officials downloaded enough offline content and apps onto the iPads so all students could practice and review content, even when they were not at school.

Electricity and batteries. There were no reports of significant increases in costs related to electricity during the pilot. For the divisions with the fewest iPads, the electricity costs were insignificant; however, any division that intends to add a significant number of devices may see some impact on electricity. One reason for the limited impact may be the extended battery lives of iPads. Most iPad batteries stay charged at least 10 hours, which more than covers a typical school day. Theoretically, if the iPads' content and functionality would become so robust that they begin to replace desktop and laptop computers, electricity costs might actually be reduced.

Syncing carts offer the convenience of charging a classroom set of devices using a single outlet. Older schools with limited access to outlets may require some retrofitting. Multi-outlet adapters could be an alternative, but users should follow manufacturer guidelines for any carts or devices to determine if these types of adapters or extension cords are recommended. Henry County Public Schools allowed students to charge their devices at home, which resulted in the loss of a few chargers, while Arlington County Public Schools sent the iPads home on Fridays with fully charged batteries.

Figure 6. Infrastructure considerations

Variable	Response	Comment
Do you already have the required type of network (e.g., wireless for most portable devices)?		Even if your network is installed, you may need additional infrastructure, such as additional wireless access points.
Will your network already support your chosen devices (e.g., if you are choosing iPads, do you already support Macs?)		
How many devices do you currently support on your network?		
The total devices proposed for start-up will comprise what percentage of devices on your network?		
Will these additional devices have a negligible, small, noticeable, or major impact on your network infrastructure?		A noticeable-to-major impact could require upgrades to your infrastructure prior to implementing your initiative and higher monthly service fees.
Will these additional devices have a negligible, small, noticeable, or major impact on your electrical infrastructure?		A noticeable-to-major impact could require upgrades to your infrastructure, including retrofitting classrooms and/or higher monthly service fees.

If you answered “no,” “noticeable,” or “major” to any of the questions above, you may want to consider the following:

Variable	Amount	Cost per Unit	Total	Comment
Additional servers			\$0.00	With a lifespan of 3-5 years
Wireless access points			\$0.00	
Labor to upgrade network			\$0.00	Can this be done internally, or does it require external labor costs?
Increased monthly fees for greater Internet speed			\$0.00	Depends whether the necessary bandwidth is available
Additional outlets			\$0.00	Review the number of outlets in the rooms where the devices will be used most often. You may want to consider an electrical audit from your service provider.
Multi-outlet adapters or surge protectors			\$0.00	If necessary
Labor to upgrade electrical infrastructure			\$0.00	To be completed by a licensed technician
Increased monthly electrical consumption fees			\$0.00	Difficult to determine
INFRASTRUCTURE SUBTOTAL			\$0.00	

PROFESSIONAL DEVELOPMENT

All new initiatives, especially involving technology, benefit from professional development—not only to help teachers and administrators use new resources but to encourage them to experiment, explore, practice, voice their concerns, and buy in to the initiative. Division leaders regularly mentioned the issue of buy-in regarding the pilot. While there are many models and strategies to choose from, professional development, especially as it relates to technology initiatives, is considered “necessary in order to transform pedagogical practice” (SETDA, 2011, p. 9). The lack of high-quality professional development can negatively impact the return on investment of any initiative.

Technology initiatives usually require two kinds of professional development activities: (1) basic operations and (2) integration, whether in the classroom or for administrative purposes. If educators do not know how to operate a device or understand how it supports their daily work, they will not use it. Division leaders reported that they provided professional development in basic operations and integration for teachers and that both topics should be presented in a cohesive manner so each one supports the other. In other words, teachers need to know how to operate the device within the context of the planned teaching and learning activities.

A common method for determining professional development funding is to allocate a certain percentage of an initiative’s overall budget, such as the recommendation in the current Elementary and Secondary Education Act (NCLB, 2001) that 25% of all technology funds received by districts be allocated to professional development. Estimating professional development costs are not always so clear, however. Schools may build professional development into other school processes, such as shared planning time, coteaching, and the use of coaches or master teachers. Funds for these types of professional learning opportunities usually come from different sources, however, and are not easily attributed to a single initiative. As a result, determining exact professional development costs can be difficult.

It is important to note that the pilot was generally considered a small initiative because it involved relatively few teachers in each division. In addition, most of the teachers were described as “tech savvy” or “early adopters” of technology. Despite this, each division provided professional development, and all the interviewed division leaders reported that professional development was still considered vital. There were some variations in terms of the amount of professional development, but most division leaders said that a half- to full-day of training prior to the project was essential; several recommended at least two full days up front to go beyond basic operations and to gain a better understanding of how the resources can be integrated into practice. All noted that opportunities for ongoing professional development should be made available throughout the year, especially when taking the initiative to scale because the project will impact more teachers, some of whom might not be “tech savvy.” During the pilot, these additional opportunities were often conducted in house by local technology experts, such as instructional technology resource teachers (ITRT), the lead teachers who routinely address the pedagogical applications of educational technologies in Virginia’s schools. Funding for ITRT does not come from this project.

Outside experts. All the divisions relied on outside experts to provide part of the professional development. Costs for these types of training are usually easier to determine than in-house training and can often be divided into categories such as fees for trainers, materials and refreshments, facility fees (minimal during the pilot since most training occurred at the schools), and stipends for attendees or substitutes to release teachers so they can attend—although, substitutes are needed only when the events occur during typical classroom hours. In addition, depending on when training opportunities are offered, it may be necessary to pay contract employees a stipend or an hourly base rate to attend.

Technical support personnel. Several division leaders noted that technical support personnel might need training, especially when adding new devices with new operating systems to a network. Copenhaver emphasized that parents should also receive training due to the importance of their buy-in to the project; the training for parents in her division emphasized how the devices would support teaching and learning and appropriate uses at home. As a result, both the parents and students were more aware of Internet safety, and these parents monitored their children’s use of the devices more closely. Because the pilot began midyear, Copenhaver’s division held extra meetings for parents prior to the start of the project. In this case, parent training was a one-time cost associated only with the pilot; in future years, these costs would be subsumed into budgets that provide for back-to-school or technology nights for parents.

Leveraging with other professional development. Division leaders confirmed they periodically offer teacher professional development related specifically to textbooks, especially when the textbooks are bundled with online and other technology-supported content and features. In addition, they routinely offer technology professional development through workshop-type events and ongoing learning opportunities for practices such as shared planning, coaching, and assistance from the ITRT. While it is critical to provide professional development for any new resource, division leaders may want to consider how these efforts can be leveraged with other options to address all the needs of a digital textbook initiative. During the pilot, one division combined its work with the digital texts with another project involving Atomic Learning, an external provider that specializes in just-in-time technology training through short videos and supporting materials. This is just one example of how divisions can integrate a digital textbook initiative with other efforts—and existing budgets—to help offset costs.

Figure 7. Potential professional development costs

Professional Development

Variable	Amount	Cost per Unit	Total	Comment
Overview and basic operations professional development				
Trainer's fees			\$0.00	Amount can be by the day or event. Recommendation is at least 1 day for overview and basic operations for teachers new to the device.
Facilities			\$0.00	If necessary
Materials			\$0.00	Handouts, notebooks, flash drives, etc.
Refreshments			\$0.00	If allowable
Stipends			\$0.00	If offered; may be hourly rate
Substitutes			\$0.00	If necessary
Pedagogical and curricular integration professional development				
Trainer's fees			\$0.00	Optional but highly recommended; default is 1 day up front, but consider additional days during the project
Facilities			\$0.00	If necessary
Materials			\$0.00	Handouts, notebooks, flash drives, etc.
Stipends			\$0.00	If offered; may be hourly rate
Refreshments			\$0.00	If allowable
Substitutes			\$0.00	If necessary
Other training				
Training for technical support staff			\$0.00	If necessary
Materials and refreshments for parent information meetings			\$0.00	If necessary outside of regularly scheduled and budgeted meetings
PROFESSIONAL DEVELOPMENT SUBTOTAL			\$0.00	

SUPPORT

As mentioned previously, divisions that did not currently support Apple devices on their networks had to incur some additional upfront costs, including professional development for some technical support personnel who were not Apple certified. Another upfront cost included unpacking and synching new devices, but, according to division leaders, a classroom set of new devices usually could be prepared in a half to a full day of work. The subsequent introduction of synching carts later reduced the amount of time needed to synch the devices and provide technical support.

During the pilot, technical support personnel fielded requests from teachers, but as the teachers and students became familiar with the most common troubleshooting issues, the requests decreased in number. The most common requests related to turning the devices on and off, connecting them to the networks, adjusting the volume, and synching them for updates. Additional technical support duties included monitoring the devices for inappropriate use and ensuring network performance, but this latter cost was often built into standard operating budgets and was not significant in the pilot programs. Estimates for total time spent on support issues varied from 10-30% of the total support requests, with the number closer to 10% after the introductory period.

In Virginia, ITRT provide pedagogical support for technology initiatives. The percentage of time ITRT spent on project-related issues was not recorded but reportedly varied from school to school. One middle school teacher reportedly was so enthusiastic about the project, he and his ITRT apparently spent more time working together than in other schools, often off the clock. While not quantifiable, enthusiasm for teaching should be considered a positive return on investment.

Like professional development, it is difficult to estimate the time or budget required to support the initiative namely because the funding for support personnel did not come directly from the project. Although technical and pedagogical support personnel can be determined by a formula (one ITRT and one technology support personnel per 1,000 students), it is highly unlikely that all teachers and students in the pilot required the same amount or types of assistance. Furthermore, support personnel may be contractual and serve many (or all) technology initiatives in a school or division, so it is impossible to attribute their costs to a specific initiative like this. However, with estimates of up to 30% of support personnel time being dedicated to starting up the initiative, this time clearly was being pulled from other work at times. Figure 8 provides some cost considerations for technical support, but keep in mind that all of these costs likely are accounted for in other budgets.

Figure 8. Technical and pedagogical support

Variable	% FTE	Cost per Unit	Total	Comment
Technical support during start-up			\$0.00	Receive and prepare devices, upgrade network, troubleshooting and maintenance requests; estimates of 10-30%
Sustained technical support after launch			\$0.00	Estimates of 5-10%
Pedagogical support during start-up			\$0.00	Intensive modeling, coaching, and just-in-time training as teachers become comfortable with the technology
Sustained pedagogical support after launch			\$0.00	Ongoing support and investigation of new opportunities to support teaching and learning; monitoring implementation
SUPPORT SUBTOTAL			\$0.00	

IMPROVING THE RETURN ON INVESTMENT

It was difficult for the division leaders to speak about the digital text in isolation. They were enthusiastic about the added value of the iPads themselves, such as their portability, the rich app “ecosystem” that supports it, and, perhaps most importantly, the potential to pull together multiple resources and applications into one easy-to-use device. The word *potential* is critical because despite reports of higher student engagement, fewer disciplinary referrals, and positive changes in teacher practice, no single, comprehensive digital textbook format or device yet exists to support teaching and learning while yielding a high return on investment (see the year one report, VDOE, 2011). The pilot included many examples of *workarounds* since iPads are not intended for multiple users. While iPads appear to be the most promising devices in terms of education, it was still difficult to incorporate them into some of the divisions’ infrastructures, and they required trial and error to implement and support. Division leaders agreed that digital textbook developers were supportive, solicited feedback from teachers, and provided updates and solutions to requests; however, the development process is still in a state of flux regarding the future of digital texts. And there may be no single solution.

For those considering the move to digital textbooks, the division leaders in the pilot listed some valuable lessons learned for reducing the bottom line. Drawn from the pilot experiences in all four divisions, consider the following cost-saving ideas to understand the TCO and to increase the learning return on investment.

Buy one (or more) and put it through the paces. A new device may require a new method to reach required goals (e.g., setting up playlists in iTunes to mimic folders or directories on common computer operating systems). Determine how it can support common teaching and learning activities, such as

- communicating and collaborating between teachers and students and among students
- creating student artifacts, such as notes, reports, and presentations that include text, URLs, images, videos, and other media
- collecting, analyzing, and reporting student data and keeping it secure
- interfacing with existing systems, including student information systems, gradebooks, or other data systems

Comparison shop. How easy is it to obtain additional hardware and software? What is the relative cost? Determine discounts for educators, such as the Apple volume-purchasing program used during the pilot, and become very familiar with the ins and outs of the program. Make sure the device will support your teaching and learning goals so it is not just a novelty.

Find out how much content the device supports. Consider both new and existing content resources. Identify critical resources that will and will NOT be supported by the device. For example, will your device support Flash (particularly important if you have a license for Flash and use Flash-based content frequently)? Are your teachers and students required to collect and report data to a learning management system that will not interface with the device? If the content on the device does not cover the entire curriculum, do your teachers have readily available options to make up the differences?

Approach major operational system upgrades with caution. Install new operating system upgrades on one or a few test devices to be sure they can provide the types of performance you need. If the operating system requires all applications on the device to be upgraded, this can use up available memory and limit performance.

Determine the vendor's level of support. Can you obtain advice and technical support about the device and your network, management of large numbers of devices, and professional development on basic operations and pedagogical applications? Do you need to train a local support expert? Would professional development from external experts at the outset help offset the cost of additional time required by internal staff to learn the product—yielding a higher return on investment?

Prepare your infrastructure. Buy one device and connect it to your infrastructure. Determine how easy—or not—it will be to add multiple devices to your network. Examine the rooms where the devices will be deployed to determine whether there are enough electrical outlets and whether the existing furniture and room layout are conducive to using the new devices.

Get buy-in and inform key stakeholders. Identify existing meetings or organizations where you can inform teachers, administrators, and parents about the initiative and get their buy-in.

Identify existing policies, practices, and budgets to support the initiative. Evaluate how you currently provide technical and pedagogical professional development and support and how this initiative could support or supplant others. Do you need to train a local expert who can then incorporate this effort into his or her scope of work? Are there internal experts who already provide support for devices like this (e.g., ITRT, who provide pedagogical support for a range of technologies)?

Determine the data you will collect to monitor effectiveness. What are the data? Who has them? How will they be collected? How do you already collect data, and can you use current methods to collect this additional information (thereby distributing costs)? Consider how you might use and obtain

- teachers' classroom records
- guidance records
- attendance and discipline information
- external achievement data
- student affective and usage data

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http://www.doe.virginia.gov/support/technology/technology_initiatives/index.shtml

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